Jan. 9, 1962 | E. E. SCHWENZFEGER | 3,016,425

FERROELECTRIC TRANSLATOR

Filed Dec. 18, 1956 | 3 Sheets-Sheet 1

FIG. 1

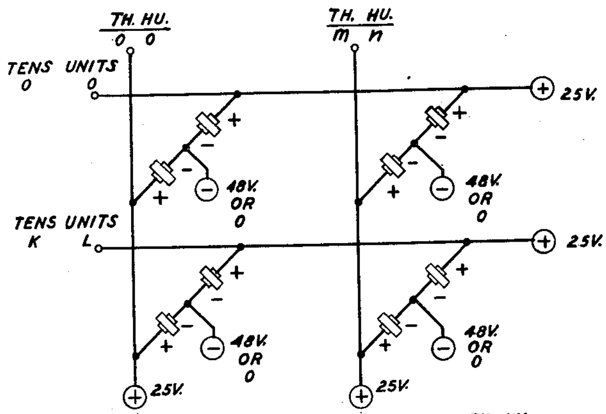


FIG. 2

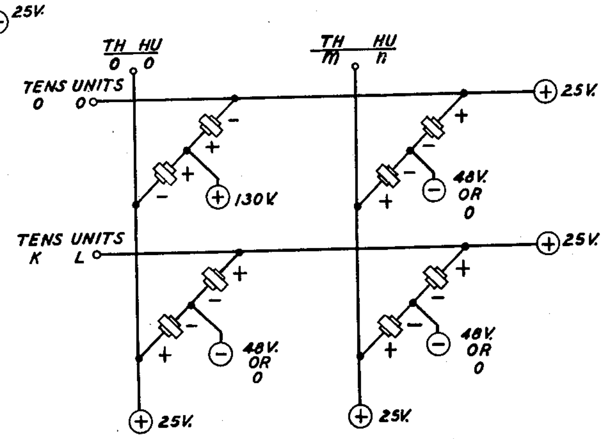
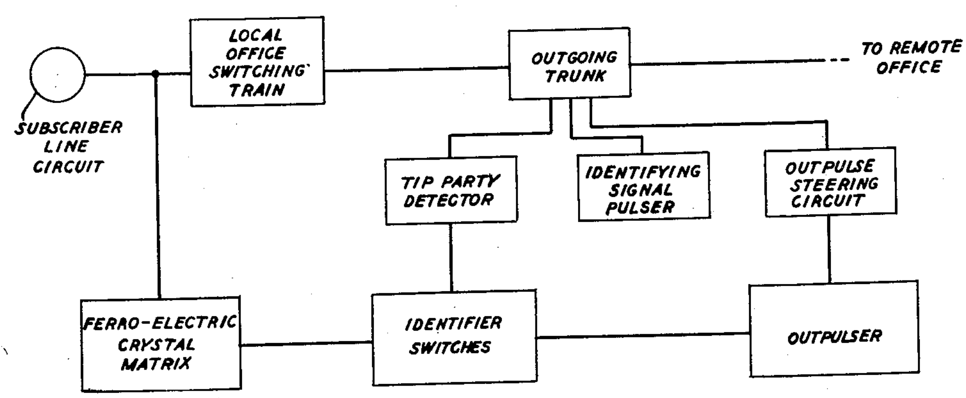


FIG. 3



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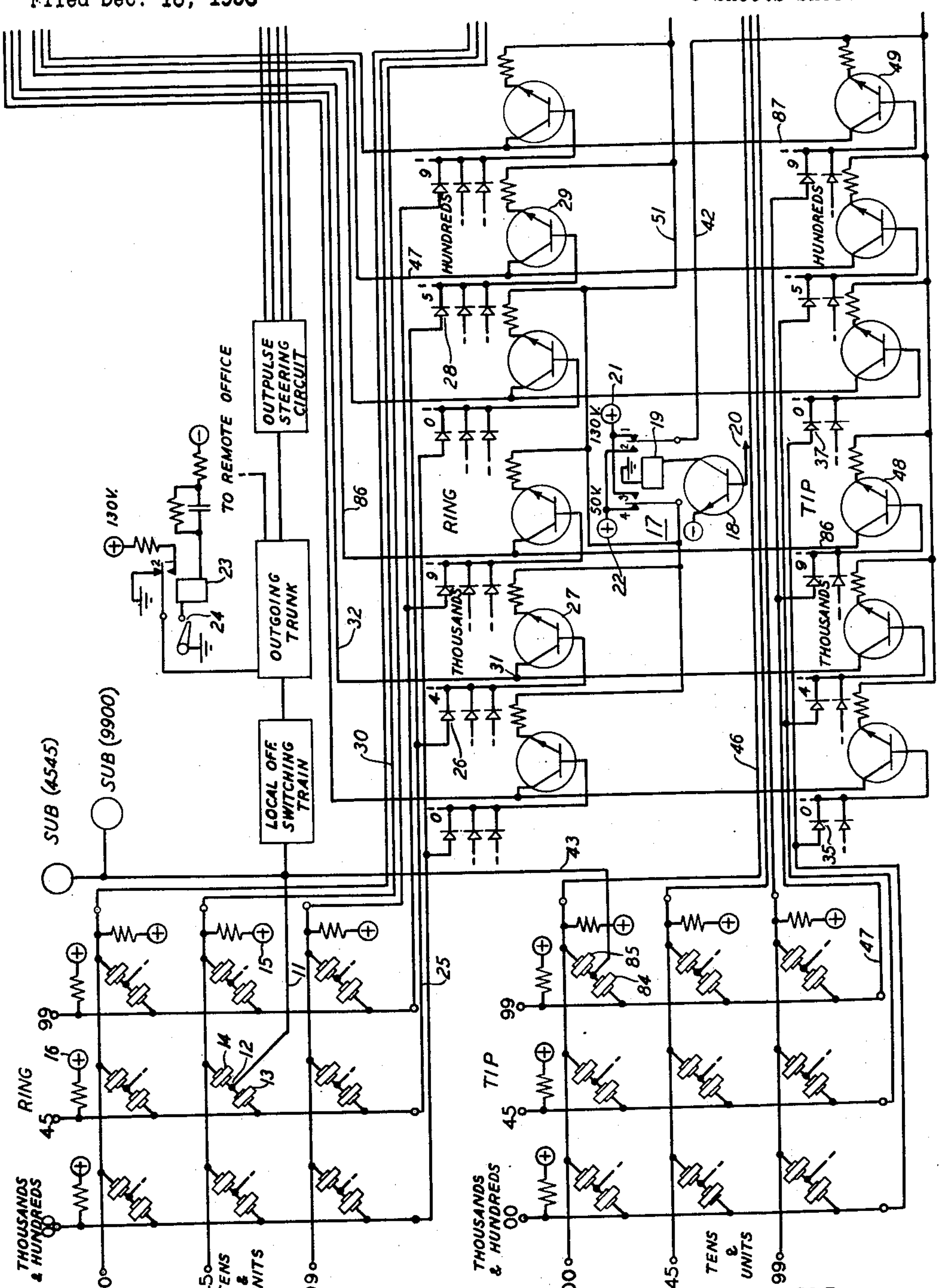

FIG. 4

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FERROELECTRIC TRANSLATOR

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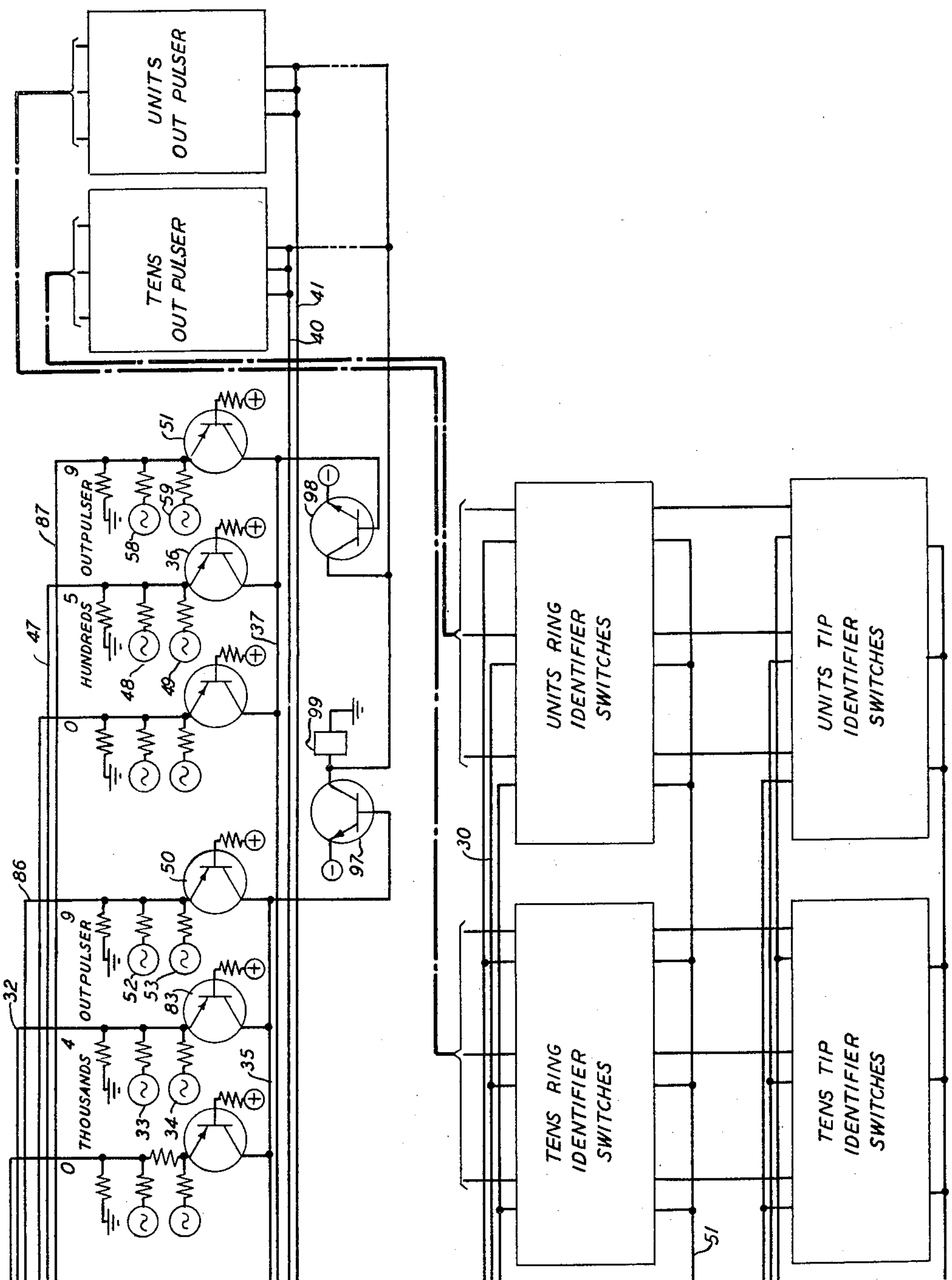

FIG. 5

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FERROELECTRIC TRANSLATOR

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11 Claims. (Cl. 179—18)

This invention relates generally to identifiers and more particularly to ferroelectric crystal matrix identifiers for establishing the identity of a telephone subscriber's directory number.

The application of an electric field to a crystal of ferroelectric material, which may by way of example be guanidine aluminum sulphate hexahydrate, barium titanate, etc., causes a momentary current flow through the crystal and the orientation of the electric dipoles therein, in a specific direction. A significant attribute of the crystal is that the dipoles remain aligned after the electric field is removed. Similarly, if the electric field is reversed, the electric dipoles reorient themselves in the opposite direction and current flows during the switching process (field reversal). If after a crystal is "set," i.e., the electric dipoles have been aligned in a particular direction, an electric field is again applied in the same direction, substantially no current will flow.

Previous identifier arrangements employing passive elements, although completely operative, exhibit certain limitations. For example, those prior art matrices which were designed to produce a high ratio of reverse-to-forward impedance, nevertheless permit the passage of a finite current in the reverse direction, thus imposing stringent requirements on the separation of signal information from noise. This separation or discrimination factor in identifier matrices fosters the necessity of high signal levels, thus enhancing the possibilities of "spill over" and "crosstalk," particularly in those identifiers employing alternating-current signals.

An additional problem which is manifest in conventional coincident current ferroelectric crystal matrices concerns the cumulative effect of partial changes in orientation of the electric dipoles. It has been found that the repeated application of a disturbing voltage to a crystal, i.e., one which is not large enough to change the polarity of the crystal, may, through cumulative effects, result in spurious transpositions of crystal polarity.

A further problem related to cumulative changes in dipole orientation is the degradation of the total output signal available from a crystal which is fully shifted in polarity after having been repeatedly disturbed or partially shifted.

Prior art matrices, moreover, are subject to the possibility of spurious operations due to the generation of transients during the switching process.

It is therefore an object of this invention to provide a ferroelectric crystal matrix in which the impedance of a crosspoint in the high impedance condition approaches infinity, thereby establishing an extremely high ratio of forward-to-reverse impedances and elevating the signal-to-noise ratio.

An additional object of the invention is to provide a ferroelectric crystal matrix in which direct-current signal information is applied to the matrix crosspoint, thereby reducing the possibility of "spill over" and "crosstalk."

A further object of this invention is to provide a crystal matrix in which switching voltages are applied to a specific crosspoint rather than to an entire row and column, thereby minimizing the number of elements to which disturbing voltages are applied.

An additional object of this invention is to provide a ferroelectric crystal matrix in which a continuous bias

voltage insures reliable polarization of all crystals at the end of each cycle.

Still another object of this invention is to decrease the possibility that transient voltages may spuriously switch a ferroelectric crystal.

A feature of this invention is the utilization of a pair of serially connected, oppositely polarized, ferroelectric crystals at each crosspoint of a matrix.

An additional feature of this invention is a transistor identifier and outpulser arrangement for registering and transmitting the identity of a subscriber's directory number to a remote telephone office.

These and other objects and features of the invention may be accomplished by the utilization of a ferroelectric crystal matrix in which each crosspoint includes two series connected crystals poled in opposing directions. A continuous polarizing voltage is applied to each crosspoint except for the brief period when the switching current is applied. The matrix of ferroelectric crystals may be incorporated, as illustrated herein, in a telephone station identifying arrangement in which a signal applied to the sleeve of an outgoing trunk circuit is extended back over an office switching train to the sleeve lead of a subscriber's line circuit, and through a cross-connection, to a particular crosspoint in the matrix of ferroelectric crystals. This signal momentarily changes the polarity of the crosspoint and causes a current to flow which can be detected by an identifier. The latter can ascertain the directory number identity and transmit it to an outpulser for further transmission over the outgoing trunk to a remote telephone office. In this description and in the claims, the term "crystal" is intended to define a body of crystalline material of the class described (ferroelectric), without limitation as to specific outward physical shape or configuration.

The invention may be better understood from an examination of the following specification, appended claims and attached drawings in which:

FIG. 1 illustrates a basic matrix configuration indicating the polarity of the ferroelectric crystals with no signal applied;

FIG. 2 illustrates the polarity of ferroelectric crystals when a signal is applied, demonstrating the application of the signal to a single isolated crystal in lieu of its being applied to an entire row or column;

FIG. 3 is a block diagram of a telephone identification system illustrating in outline form the subscriber line circuit, ferroelectric matrix, identifier switches, outpulser and associated equipment;

FIG. 4 illustrates in further detail the circuitry of the ferroelectric crystal matrix and identifier switch portions of the identification system of FIG. 3; and

FIG. 5 illustrates in further detail the circuitry of the outpulser and identifier switches indicated in outline form in the identification system in FIG. 3.

Referring now to FIG. 1, an elementary crystal matrix, including four crosspoints of two crystals each, is shown for purposes of illustration.

Potentials indicated at the mid-point of each crosspoint are intended to be exemplary of the condition found on the sleeve of a subscriber's line circuit, i.e., —48 volts if the line is idle and zero volts or ground when the line is busy. A continuous application of +25 volts to all of the rows and columns establishes opposite polarities in each of the two crystals at a given cross point. (It is understood that the specific voltages enumerated above and hereinafter are merely illustrative and that other suitable voltages may be employed.)

If the potential present at the mid-point of a particular crosspoint is driven positive, to +130 volts, for example, the polarity of the crystals connected thereto is reversed and a momentary current will flow through the crystals and the row and column busses associated with the crosspoint. In FIG. 2, crosspoint 0000 (upper left) is shown being switched according to the foregoing conditions. It is seen that the polarities of all other crystals in the matrix are retained in their initial state. Since two series connected crystals poled in opposing directions afford an extremely high impedance to the flow of series current therethrough, substantially no current resulting from the switching of crosspoint 0000 can traverse any other crosspoint to other busses of the matrix.

Having thus illustrated the basic principles of operation of the ferroelectric matrix, a general description of the operation of the telephone directory number identification system illustrated in outline form in FIG. 3 will be given.

A subscriber desiring to communicate with a distant office dials the called directory number in the usual manner and is connected through suitable switching trains in his local office to an outgoing trunk extending to the remote office.

At a signal from the remote office, the outgoing trunk is directed to seize an identifier for the purpose of ascertaining and transmitting the calling subscriber's directory number to the remote office for billing or other purposes. A tip party detector which detects a ground on the tip party's substation equipment determines whether the subscriber's line circuit is associated with a tip party or a ring party and conditions the identifier switches, by means described herein, to identify the correct party. An identifying signal pulser then impresses on the sleeve of the outgoing trunk a short direct-current pulse which is transmitted back through the local office switching train to the sleeve of the subscriber's line circuit. The pulse is further conveyed through a cross-connecting conductor to the common junction of the two crystals which make up a particular matrix crosspoint representative of the directory number of the calling subscriber's line. A single ferro-electric matrix is shown in FIG. 3 for clarity, but it is understood that separate matrices for tip and ring parties may be utilized as illustrated in FIG. 4.

The identifying signal, when applied to the midpoint of the associated pair of ferroelectric crystals, changes the polarity of said crystals and causes a momentary current to flow in the busses associated with said crystals.

Through cross-sections from the row and column busses of the crystal matrix, identifier switches including separate groups of transistors for the thousands, hundreds, tens and units designation of the directory number are energized. This information is then transmitted to the outpulser for code conversion and transmission via the outpulse steering circuit to the remote office. Subsequently, the outpulser is operated to transmit the calling directory number to the remote office by two-out-of-five code multifrequency pulses.

DETAILED DESCRIPTION

Having thus described in a general manner the structure and operation of the invention, a detailed description of the operation including specific illustrations of the procedure associated with a particular call follows:

It may be assumed that a subscriber SUB (4545) in FIG. 4 has placed a call to a remote office by dialing the appropriate called directory number digits. A cross-connection **11** interconnects the directory number termination of the calling subscriber with the mid-point **12** of crosspoint 4545 in the ferroelectric crystal matrix as shown. Crosspoint 4545 includes two series connected ferroelectric crystals **13** and **14**. The distal ends of crystals **13** and **14** are connected to the thousands and hundreds bus bar 45 and the tens and units bus bar 45, respectively. Application of a +25 volt potential from sources **15** and **16** maintains crystals **13** and **14** in oppositely polarized states.

The initial procedure in identification is to ascertain whether the calling party is a tip or ring party. The tip party detector **17** includes a transistor switch **18** and relay **19** which respond to the presence or absence of a ground condition at the subscriber's substation SUB. It is assumed for the purposes of this explanation that the conventional practice is to arrange the subscriber's substation equipment in order that tip party equipments place a ground condition on the conductors whereas ring party equipments do not. Lead **20** from the base of transistor **18** is connected to the tip conductor (not shown) in the outgoing trunk circuit. Inasmuch as, in the assumed illustration, subscriber SUB is a ring party subscriber (or private line subscriber—private line subscribers being connected to the ring matrix) no ground condition is transmitted through conductor **20** and consequently transistor **18** remains in the "off" condition and associated relay **19** remains unoperated.

Under these conditions, +130 volt potential from source **21** is applied over the No. 1 contacts of relay **19** to the transistor emitters of the tip party thousands, hundreds, tens and units identifier switches. Each of the tip and ring identifier groups includes ten n-p-n transistor switches of which only three are shown, as illustrative, in the thousands and hundreds group of both the ring and tip identifiers as explained herein.

Similarly, the tip party detector places a +50 volt potential from source **22** over the No. 4 contacts of relay **19** on all of the emitters of the transistors in the ring party thousands, hundreds, tens and units identifier.

Since the identifying signal applied to the midpoint of a selected crosspoint is designed to be approximately +130 volts, it is apparent that this signal when applied to the bases of associated transistors in the ring party identifier by means hereinafter explained, will enable said transistors. On the other hand, with the high +130 volt positive potential applied to the emitters of each of the transistors in the tip party identifier, none of these transistors can respond to less than a +130 volt signal applied to their bases.

Continuing with the operation, after preconditioning of the circuit for ring party identification, the identification signal relay **23** is operated by momentarily closing switch **24**. This type of operation of relay **23** is symbolic. For the automatic application of an identifying signal to a line sleeve, reference may be made to Patent No. 2,629,-016 to J. W. Gooderham on February 17, 1953.

However effected, the operation of relay **23** drives a +130 volt signal through the switching train to the mid-point **12** associated with the calling subscriber's line. The mid-point **12** of crosspoint 4545 is rapidly driven from ground potential at the No. 2 contacts of relay **23** to +130 volts at the No. 1 contacts of relay **23** and back to ground potential. This sharp positive pulse causes the ferroelectric crystals **13** and **14** to momentarily shift in polarity thereby causing a momentary current to flow in the associated thousands and hundreds bus bar 45 and tens and units bus bar 45 connected to the distal ends of the crystals. Assuming a +25 volt bias on all the bus bars, the current flow through the selected bus bars causes the potential thereon to shift from +25 volts to approximately +100 volts. This increased potential may be further traced to cross-connected busses in the ring party identifier switches thousands, hundreds, tens and units groups.

For example, a voltage appearing on thousands and hundreds bus bar 45 may be traced through conductor **25**, diode **26** to the No. 4 bus bar in the thousands group and to the base of transistor **27**. The signal may be further traced through diode **28** to the No. 5 bus bar in the hundreds group of the ring party identifier switches and to the base of transistor **29**.

Similarly, it may be shown that the signal appearing on tens and units bus bar 45 may be traced over conductor **30** to the No. 4 bus bar (not shown) in the tens ring identifier switches and the No. 5 bus bar (not shown) in the units ring identifier switches of FIG. 5. (For a complete description, FIG. 5 should be placed to the right of FIG. 4.)

In summary then, the effect of the +130 volt signal at the mid-point of crosspoint 4545 is to produce approximately a +100 volt potential on the base of each of the four associated n-p-n transistors in the ring identifier switches.

Since, as previously explained, the voltage on the emitters of all the transistors in the ring party identifier switches is at a +50 volt potential, it is apparent that the four selected transistors will be driven into the "on" condition.

It is understood that although only nine crosspoints are shown in both the tip and ring party ferroelectric crystal matrices of FIG. 4, as many as 10,000 crosspoints may be employed in each matrix by using a coordinate array of one hundred thousands and hundreds bus bars and one hundred tens and units bus bars. Similarly, although connections are shown for only the limited number of bus bars in the crystal matrices for purposes of clarity, an individual connection is contemplated between each of the bus bars and the appropriate two transistor identifier switches representing the digital designation of the associated bus bar in the crystal matrix.

Also, it may be seen that, for simplicity, only a partial representation of the transistors in the ring and tip party identifier switches are set forth. It is assumed, however, that a full complement of ten transistors will be used in each of the thousands, hundreds, tens and units groups in lieu of the three transistors each shown in the thousands and hundreds groups.

The tens and units groups in both the tip and ring party identifier switches are shown in outline form only (in FIG. 5) but are assumed to include identical transistor circuitry with the thousands and hundreds units, respectively.

Continuing the operation, it has been demonstrated that the momentary application of a +130 volt signal to the mid-point of crosspoint 4545 will result in the activation of a single transistor in each of the thousands, hundreds, tens and units groups of the ring identifier switches indicative of the digital representation of the subscriber's directory number.

The activation of transistors **27** and **29** in the thousands and hundreds groups of the ring identifier switches, respectively, and the activation of corresponding transistors (not shown) in the tens and units ring identifier switches, collectively result in the energization of associated transistors in the outpulser shown in FIG. 5.

Specifically, the energization of transistor **27** in the thousands group of the ring identifier produces a potential excursion at the collector junction **31** from approximately zero volts or ground potential to approximately the emitter potential or +50 volts. This positive voltage pulse may be traced from the collector junction **31** of transistor **27** over conductor **32** to transistor switch **83** in the thousands group of outpulsers. This steep potential pulse applied to the emitter of transistor **83** initiates transistor action therein, thereby substantially reducing the impedance between emitter and collector and establishing a conductive path for the signals generated by the alternating-current signaling devices **33** and **34**.

The devices **33** and **34** are symbolic representations of part of a multifrequency signaling source adapted to transmit signal information on a digital basis in accordance with a prearranged code in which a particular combination of two of five possible frequencies represent the digital values. Reference may be made to Patent No. 2,288,251 to P. B. Murphy of June 30, 1942, and the patents therein referred to for a complete exposition of a suitable multifrequency signaling device. The relationship between the digital values and the generated frequencies corresponding thereto are expressed according to the following code:

Table I

Digit:	Frequencies in cycles per second
1	700+900
2	700+1100
3	900+1100
4	700+1300
5	900+1300
6	1100+1300
7	700+1500
8	900+1500
9	1100+1500
0	1300+1500

Consequently, the energization of transistor **83**, representing the thousands digit 4, results in the application of two frequencies consisting of 700 cycles and 1300 cycles, to conductor **35**, extending to the outpulse steering circuit of FIG. 4. Similarly, energization of transistor **29** in the hundreds ring identifier switches results in the activation of transistor **36** in the hundreds outpulser over conductor **47**. Signal sources **48** and **49**, adapted to represent the digit 5 in the two-out-of-five multifrequency code set forth above, apply frequencies of 900 cycles and 1300 cycles through transistor **36** to conductor **37** and the outpulse steering circuit.

In like fashion, individual transistors (not shown) representing the tens digit 4 and units digit 5 are energized in the tens outpulser and units outpulser, respectively. The energization of these transistor switches results in the application of the appropriate two-out-of-five multifrequency code to leads **40** and **41** to the outpulse steering circuit from the tens outpulser and units outpulser, respectively.

An outpulse steering circuit, not shown in detail herein but described in the patent to P. B. Murphy referred to above, is utilized to sequentially connect conductors **35**, **37**, **40** and **41** to the outgoing trunk, thereby serially transmitting the identification of the directory number of the calling party in two-out-of-five multifrequency code, which information may be utilized at the remote office end of said trunk for billing or other purposes. The equipment for receiving the multifrequency code signals at the distant office is not shown herein. Reference may be made to Patent No. 2,332,912, granted October 26, 1943, to G. Hecht, for a disclosure of apparatus suitable therefor.

Transistor switch **83** and the other outpulser switches, may, for example, be arranged to stay in the "on" position after receiving a steep positive pulse on the emitter. Thus, the alternating-current signals remain on leads **35**, **37**, **40** and **41** until the associated transistor switches are turned off by the release of the identifier, by means not shown herein.

Individual check transistors **97** and **98** are connected to each of the outpulse leads **35** and **37**. Similar check transistors (not shown) are connected to leads **40** and **41**.

Normally, if only a single transistor switch **36**, **83**, etc., is connected to each outpulse lead **37**, **35**, etc., the check transistors remain in the high impedance condition. However, if more than one transistor switch is connected to an outpulse lead, the base of the associated check transistor is driven sufficiently positive to initiate transistor action, thereby operating relay **99** to indicate the trouble condition.

In the foregoing explanation of operation, reference has specifically been made to the identification of a directory number of a ring party. However, the identification of tip party subscriber 9900 connected to the same line loop as ring party subscriber 4545 referred to above, proceeds in a substantially similar manner. In this instance, the tip party detector **17** recognizes a ground condition at the customer substation set causing transistor **18** to operate over conductor **20**, thereby operating relay **19**. Under these conditions, a +50 volt potential is applied through the No. 2 contacts of relay **19** to all of the emitters in the tip party identifier transistors over conductor 42. Likewise, a +130 volt potential is applied over contacts 3 to all the emitters of the ring party identifier transistors, resulting in their disablement.

As explained above, the identification procedure would include application of a 130 volt signal from the No. 1 contacts of relay 23 over the subscriber's line sleeve and cross-connection 43 to the mid-point of crystals 84 and 85. This results in the momentary switching of said crystals and current flow through bus bars 99 and 00 and conductors 46 and 47 to the tip party identifier switches resulting in the enabling of transistors 48 and 49 in the thousands and hundreds groups, and corresponding transistors (not shown) connected to conductor 46 in the tens and units groups. As explained above, transistors 50 and 51 in the thousands and hundreds outpulsers are energized over conductors 86 and 87 and similar transistors (not shown) in the tens and units outpulsers are also energized. This results in the application of a combination of frequencies of 1100 and 1500 cycles from sources 52 and 53 to conductor 35 and the outpulse steering circuit. Transistor 51 would apply a similar group of frequencies to conductor 37 from sources 58 and 59. Similarly, transistors (not shown) representing the digit 0 in both the tens and units outpulser would apply a group of frequencies representing the digit 0 i.e., 1300 and 1500 cycles to conductors 40 and 41, respectively, to the outpulse steering circuit.

As discussed above, the outpulse steering circuit will sequentially connect each of the conductors 35, 37, 40 and 41 to the outgoing trunk for transmission to the remote office.

It is seen from an examination of FIGS. 1, 2 and 4 that a continuous bias voltage is applied to each of the crosspoints maintaining an oppositely polarized state in each of the two crystals. It is further noted that this condition persists when the lines are idle and at −48 volts or when busy and at zero volts. As a result, current flow through any two bus bars in consequence of the shift of polarity at a particular crosspoint responsive to the application of an identifying signal thereat, cannot be transmitted through other crosspoints to other bus bars in view of the extremely high impedance exhibited by two series connected oppositely polarized ferroelectric crystals. Thus, it is seen that the signal-to-noise ratio is extremely high, facilitating discrimination and detection of the desired signals.

In addition, the continuous bias potential decreases the possibility of spurious transformations of crystal polarity as a result of transients in the switching train or elsewhere.

It is understood that the specific voltages referred to above are used only as exemplary and that other appropriate voltage levels may be used to afford additional operative embodiments.

It is further understood that the embodiments shown are merely exemplary and that various modifications may be made without departing from the scope or spirit of the invention.

What is claimed is:

1. A ferroelectric crystal matrix translator including an array of row conductors and column conductors, a plurality of pairs of serially connected ferroelectric crystals, means connecting the distal ends of said pairs of crystals between said row and column conductors at the crosspoints thereof, a polarizing source connected to said row and column conductors for polarizing said crystals in each pair in opposing directions, means for applying a signal to the mid-point of a selected pair of crystals thereby momentarily reversing the polarity of the pair of selected crystals, and a plurality of transistor switches connected to said row and column conductors for detecting changes of current produced as a result of changes in polarity of the selected pair of ferroelectric crystals.

2. A ferroelectric crystal matrix translator including an array of horizontal and vertical bus bars, a plurality of pairs of serially connected ferroelectric crystals, means connecting the distal ends of said pairs of crystals to said horizontal and vertical bus bars at the crosspoints thereof, means for continuously polarizing said crystals in each pair in opposing directions, means for applying to the mid-point of a selected pair of crystals a signal to be translated thereby momentarily reversing the polarity of said selected pair, a plurality of transistors each including a base electrode, an emitter electrode, and a collector electrode, means for biasing said transistors, and means connecting the bases of said transistors to said horizontal and vertical bus bars in accordance with a code, said transistors being responsive to changes in current in said bus bars produced as a result of changes in polarity of said selected pair of ferroelectric crystals.

3. A ferroelectric crystal matrix translator including an array of horizontal and vertical conductors, a plurality of pairs of serially connected ferroelectric crystals, means connecting the distal ends of said pairs of crystals to said horizontal and vertical conductors, signal conductors, means connecting the mid-points of said pairs of crystals to said signal conductors, potential means connected to said horizontal and vertical conductors for polarizing said crystals in each pair in opposing directions, means for applying a signal to a particular signal conductor connected to the mid-point of a selected pair of crystals, a first plurality of transistors connected to said horizontal and vertical conductors and responsive to changes of current produced by changes in polarity of said selected pair of crystals for ascertaining the identity of said particular signal conductor, and a second plurality of transistors connected to and controlled by said first plurality of transistors for generating alternating-current signals representative of said identity.

4. A calling line directory number identifier including an array of horizontal and vertical bus bars, a plurality of pairs of serially connected ferroelectric crystals, means for connecting the distal ends of said pairs of crystals to said bus bars, means individually connecting the mid-points of said pairs to a plurality of lines to be identified in accordance with the directory number designation of said lines, means for polarizing the crystals in each pair in opposing directions, means for applying a direct-current signal to said calling line to be identified thereby momentarily reversing the polarity of a selected pair of crystals, thousands, hundreds, tens and units switches connected to said horizontal and vertical bus bars and responsive to changes in current created as a result of changes in polarity of said selected pair for ascertaining the identity of the directory number to be identified, thousands, hundreds, tens and units signaling devices connected to and controlled by said switches for transmitting multifrequency alternating-current signals representative of the digital value of the identified directory number.

5. An identifier for ascertaining the directory number designation of each of a plurality of telephone stations, each directory number comprising four digits, said identifier including an array of horizontal and vertical conductors, said vertical conductors designating the thousands and hundreds digits of said directory number, said horizontal conductors designating the tens and units digits of said directory number, a plurality of pairs of serially connected ferroelectric crystals joining said horizontal and vertical conductors at the crosspoints thereof, each of said telephone stations being connected to the mid-point of a pair of said ferroelectric crystals, polarizing means connected to the distal ends of each pair for continuously polarizing the crystals in each pair in opposing directions, a source of reference potential, means connecting the mid-point of each pair to said source of reference potential, means for temporarily disconnecting said reference potential from the mid-point of a selected pair of crystals connected to the telephone station to be identified, means for applying a direct-current signal to the mid-point of said selected pair thereby momentarily reversing the polarity

of said selected pair of crystals, and means connected to said vertical and horizontal conductors and responsive to changes in current created as a result of changes in polarity of said selected pair of crystals for registering the identity of said telephone station to be identified.

6. A telephone station directory number identifier comprising in combination, a first and second coordinate array of conductors, the conductors in each array being joined at their crosspoints by pairs of serially connected ferroelectric crystals, the conductors in each of said arrays including two groups of one hundred conductive paths, one of said groups being disposed vertically and designating the thousands and hundreds digits of telephone directory numbers, the other of said groups being disposed horizontally and designating the tens and units digits of telephone directory numbers, a plurality of tip and ring telephone stations to be identified, each of said stations being connected to at least one of said pairs of crystals, means for polarizing each of the said crystals in a pair in opposing directions, means for applying a direct-current signal to the mid-point of the selected pair of crystals connected to the telephone station to be identified thereby momentarily changing the polarity of said pair of crystals, party detection means connected to said telephone station to be identified for determining the tip or ring party identity of said station, two groups of transistor switching means connected to said vertical and horizontal conductors in both of said arrays and responsive to changes in current created as a result of changes in polarity of said pair of crystals for ascertaining the four-digit designation of the telephone station to be identified, and means responsive to the operation of said party detection means for disabling one of said groups of transistor switching means.

7. A matrix crosspoint switching device including a pair of serially connected ferroelectric crystals, a source of reference potential, means for applying continuous biasing potential to the distal ends of said crystals and means connecting the mid-point of said pair to said source of reference potential, thereby producing an opposite polarization in each of said crystals, utilization circuits connected to the distal ends of said crystals, and means for momentarily disconnecting said mid-point from said source of reference potential and applying a signal potential to said mid-point to momentarily reverse the polarity of said ferroelectric crystals thereby creating momentary currents flow in said utilization circuit.

8. An identifier for ascertaining the directory numbers of telephone stations in a telephone system, comprising a first and second coordinate array of conductors, each of said arrays including two groups of one hundred conductive paths, one of said groups being disposed vertically to designate the thousands and hundreds digits of said station directory numbers, the other of said groups being disposed horizontally to designate the tens and units digits of said station directory numbers, a plurality of tip and ring telephone stations to be identified, a plurality of pairs of serially connected ferroelectric crystals joining said conductors at the crosspoints thereof, each of said pairs of crystals designating a particular directory number, means connecting each of said stations to the mid-point of at least one of said pairs of crystals, means for polarizing the said crystals in each pair in opposing directions, means for applying a direct-current signal to said telephone station to be identified thereby momentarily reversing the polarity of the crystals connected thereto, two groups of thousands, hundreds, tens and units transistor devices connected to said horizontal and vertical conductive paths in each of said arrays and responsive to changes in current created as a result of changes in polarity of said crystals for ascertaining the four-digit designation of the telephone station to be identified, party detection means connected to said telephone station to be identified and responsive to potential conditions at said telephone station for determining the tip party or ring party identity of said station, means connected to and responsive to the operation of said party detection means for disabling one of said groups of transistor devices, and thousands, hundreds, tens and units transistor signal generators connected to and controlled by said groups of said transistor devices for generating alternating-current signals indicative of the four-digit directory number identification of said station to be identified.

9. A ferroelectric crystal matrix identifier for determining the four-digit directory number of telephone stations in a telephone system, comprising in combination a first and second coordinate array of conductors, each of said arrays including two groups of one hundred conductive paths, one of said groups being disposed vertically and designating the thousands and hundreds digits, the other of said groups being disposed horizontally and designating the tens and units digits, the conductors in each of said arrays being joined at their crosspoints by serially connected pairs of ferroelectric crystals, a plurality of tip and ring telephone stations to be identified, each of said stations being connected to at least one pair of said crystals, means for polarizing the said crystals in each pair in opposing directions, means for applying a direct-current signal to the telephone station to be identified thereby momentarily changing the polarity of the crystals connected thereto, party detection means responsive to potential conditions at said telephone station to be identified for determining the tip or ring identity of said station, two groups of thousands, hundreds, tens and units transistor means individually connected to said first and second coordinate arrays and responsive to changes in current created as a result of changes in polarity of said pairs of crystals for ascertaining the four-digit directory number designation of the telephone station to be identified, thousands, hundreds, tens and units transistor signal generators connected to and controlled by said groups of transistor means for generating multifrequency alternating-current signals according to a code representing the four-digit designation of the telephone station to be identified, means responsive to the operation of said party detecting means for disabling one of said groups of said transistor means, and a plurality of diodes individually serially connected between each of said horizontal and vertical conductors in each of said arrays and said transistor means.

10. A telephone station directory number identifier for ascertaining the directory numbers of telephone stations in a telephone system, comprising in combination a first and second coordinate array of conductors, each of said arrays including two groups of 100 conductive paths, one of said groups being disposed vertically to designate the thousands and hundreds digits of telephone directory numbers, the other of said groups being disposed horizontally to designate the tens and units digits of telephone directory numbers, a plurality of tip and ring telephone stations to be identified, a plurality of serially connected pairs of ferroelectric crystals joining said conductors at the crosspoints thereof, each of said pairs of crystals representing a particular directory number, each of said telephone stations being connected to the mid-point of at least one of said pairs of crystals, means for polarizing the said crystals in each pair in opposing directions, means for applying a direct-current signal to the telephone station to be identified thereby momentarily reversing the polarity of the crystals connected thereto, two groups of thousands, hundreds, tens and units transistor devices individually connected to said first and second coordinate arrays and responsive to changes in current created as a result of changes in polarity of said crystals for ascertaining the four-digit designation of the telephone station to be identified, party detection means connected to said telephone station to be identified and responsive to potential conditions at said telephone station for determining the tip party or ring party identity of said station, means connected to and responsive to the operation of said party

detection means for disabling one of said groups of transistor devices, thousands, hundreds, tens and units transistor signal generators connected to and controlled by said first and second groups of transistor devices for generating alternating-current signals indicative of the four-digit directory number identification of said station to be identified, and individaul transistor checking means connected to and controlled by said transistor signal generators for detecting and indicating erroneous operations of said generators.

11. A switching device including a pair of serially connected ferroelectric crystals, a source of reference potential, means for applying a polarizing potential to the distal ends of said crystals and means connecting the mid-point of said pair to said source of reference potential thereby producing an initial condition of opposite polarization in each of said crystals, utilization circuits connected to the distal ends of said crystals, means for momentarily disconnecting said mid-point from said source of reference potential and applying a signal potential to said mid-point to reverse the polarity of said ferroelectric crystals thereby creating a momentary current flow in said utilization circuits, and means for reconnecting said mid-point to said source of reference potential to reestablish the initial polarization condition in said crystals.

References Cited in the file of this patent

UNITED STATES PATENTS

2,244,700	Horton	June 10, 1941
2,666,195	Bachlet et al.	Jan. 12, 1954
2,695,396	Anderson	Nov. 23, 1954
2,695,398	Anderson	Nov. 23, 1954
2,717,373	Anderson	Sept. 6, 1955
2,749,387	Barlow et al.	June 5, 1956